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ART. 14. A STUDY OF THE SALAMANDER,
AMBYSTOMA CINGULATUM,
WITH THE DESCRIPTION OF A NEW SUBSPECIES

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(PLATE 1)

Ambystoma cingulatum Cope belongs to the group of salamanders of the genus *Ambystoma* which have the plicæ of the tongue diverging from a median furrow rather than radiating from the posterior base of the tongue. Included in this group are *cingulatum*, *annulatum*, *texanum* (*sensu lato*), *mabeei*, and probably *schmidti* of Mexico. In addition to the character of the tongue, *annulatum*, *texanum*, and *cingulatum* are further characterized by multiple rows of teeth on the jaws, and in *cingulatum* and *annulatum* the individual tooth terminates in a rounded knob rather than in a point. *A. cingulatum* differs from *annulatum* in its smaller size, much narrower head, and in that the pattern is not composed of just a few pronounced annuli.

Although it has been more than eighty years since *A. cingulatum* was first described by Cope (1867: 205), remarkably little new information has been added to the original description, primarily because no one seemed to know where to look for the species. Within the past several years two persons have independently found how to collect the form and a fair amount of recent material has thus become available. Wilfred T. Neill, formerly of Augusta, Georgia, and now with Ross Allen's Reptile Institute, has been successful in collecting the species on the Atlantic Coastal Plain of Georgia and South Carolina, and Mr. Harvard E. Nygren, a student of the University of Florida, has discovered a population of *cingulatum* just north of Pensacola in Escambia County, Florida. Both of these gentlemen have kindly collected fresh material for me. More recently, since the habitat of the species has become known, other interested persons have collected specimens. There has thus been made available to me more than five times as much material as any previous worker has had.

Examination of this recent material, much of which I have seen alive, and re-examination of specimens heretofore available in collections, revealed that *cingulatum* is made up of two well-differentiated subspecies, one on the Atlantic Coastal Plain and the other on the Gulf Coastal Plain. Since the type locality for *cingulatum* is Grahamville, South Caro-

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lina, this name must be applied to the Atlantic Coast form. No name appears available for the Gulf Coast population and I therefore take pleasure in naming it in honor of my distinguished friend, Dr. Sherman C. Bishop.

***Ambystoma cingulatum bishopi*, subsp. nov.**

RETICULATED SALAMANDER

(PLATE 1)

1917. *Ambystoma cingulatum* Stejneger and Barbour, *A Check List of North American Amphibians and Reptiles*, 1st ed., p. 8 (part).—Dunn, *Bull. Mus. Comp. Zoöl.*, Vol. LXII, no. 9, 1918, p. 458.—Löding, *Geol. Surv. Ala.*, Mus. paper no. 5, 1922, p. 11.—Stejneger and Barbour, *A Check List of North American Amphibians and Reptiles*, 2nd ed., 1923, p. 4 (part).—Stejneger and Barbour, *A Check List of North American Amphibians and Reptiles*, 3rd ed., 1933, p. 4 (part).—Wright, *Proc. Nat. Acad. Sci.*, Vol. XXI, no. 6, 1935, pp. 340, 341 (part).—Wright, *Science*, Vol. LXXXI, no. 2106, 1935, p. 463 (part).—Stejneger and Barbour, *A Check List of North American Amphibians and Reptiles*, 4th ed., 1939, p. 7 (part).—Carr, *Univ. Fla.*, *Biol. Sci. Ser.*, Vol. III, no. 1, 1940, pp. 30, 46 (part).—Orton, *Copeia*, 1942, no. 3, pp. 170, 171.—Bishop, *Handbook of Salamanders*, 1943, pp. 113, 123-126 (part).—Stejneger and Barbour, *Bull. Mus. Comp. Zoöl.*, Vol. XCIII, no. 1, 1943, p. 9 (part).—Allen and Neill, *A checklist of the amphibians and reptiles of Florida*, 1949, p. 1 (part).
1940. *Ambystoma texanum* Carr, *Univ. Fla.*, *Biol. Sci. Ser.*, Vol. III, no. 1, pp. 30, 46.

Type: Carnegie Museum, no. 29,137, adult female, collected about five miles north of Pensacola, Escambia County, Florida, May 7, 1949, by Harvard E. Nygren, and preserved on December 8, 1949.

*Paratypes*¹: Sixty-two, as follows: Alabama: Mobile Co., Mobile; USNM 42,861, 57,389-90. Florida: Calhoun Co., Scott's Ferry; ERA-WTN 14,004 (32); Escambia Co., Pensacola; DBUF 34; about 5 mi. N. Pensacola, AMNH 54,742, ANSP 26,274-75, SCB, 1,546-47, CM 29,138-144, CAS, 15,550-51, DBUF, 2,627, CJG 1,869 (alive), MCZ 26,754-55, Tulane 11,824, UMMZ 100,982-83; Jackson Co., near Cottondale; UMMZ 77,062 (2); Mariana; UMMZ 73,989. Georgia: Baker Co., 1.5

¹ ERA-WTN, E. Ross Allen-Wilfred T. Neill collection; AMNH, American Museum of Natural History; ANSP, Academy of Natural Sciences of Philadelphia; SCB, personal collection of Sherman C. Bishop; CM, Carnegie Museum; CAS, Chicago Academy of Sciences; JWC, personal collection of John W. Crenshaw; DBUF, Department of Biology, University of Florida; CJG, personal collection of Coleman J. Goin; MCZ, Museum of Comparative Zoölogy; Tulane, Department of Zoology, Tulane University; USNM, United States National Museum; UMMZ, University of Michigan, Museum of Zoology.

mi. NNE junction of Early, Miller, and Baker counties; JWC 293; Early Co., junction of Colquit-Blakely and Hilton-Damascus roads; UMMZ 100,695.

Diagnosis: An *Ambystoma* with multiple rows of knob-like teeth on both jaws and on the vomers and with a dorsal pattern of reticulations formed by narrow, orange-gray lines on a chocolate-black background; ventrally the pattern may be described as tiny gray flecks on a dark background giving a salt and pepper appearance. From *Ambystoma cingulatum cingulatum* it differs in its more robust build, in having a ventral pattern salt and pepper in appearance rather than a series of discrete white spots on a dark background, in having a more reticulate dorsal pattern, and in showing a tendency toward having the vomerine teeth arranged in two rows rather than three, and fewer in number (average 13.2 in each patch in *bishopi*, 15.6 in each patch in *cingulatum*).

Description of Type: Skin smooth on dorsum and venter, heavily wrinkled on sides between axilla and groin. No large glands present. No discernible rows of mucous pores on head.

Head (as seen from above) somewhat elongate, the sides nearly parallel behind the eyes, in front of eyes tapering to a rounded snout; as seen from side, somewhat depressed, only slightly arched above; snout projecting beyond tip of lower jaw. Outline of mouth nearly straight posteriorly, curving down anteriorly; angle of mouth below posterior margin of eye. No canthus rostralis. Nostrils small, semicircular, anterior in position being located nearly at tip of snout; distance between nostril and anterior corner of eye equals length of eye; distance between nostrils equals about two-thirds length of eye. Eye moderate in size, distance from tip of snout just slightly exceeding length of eye. Upper eyelid fitting over lower eyelid both anteriorly and posteriorly. A distinct groove passes downward and backward from posterior corner of eye to behind base of jaw where it forks, one branch extending downward and the other branch curving upward and posteriorly, nearly reaching the gular fold on the side of the head. The gular fold extends well up on the side of the neck on each side, ventrally it forms a very obtuse angle directed anteriorly. Head width 5.42 times in body length; head length 3.35 times in body length.

Body somewhat slender for an *Ambystoma*, very slightly flattened dorso-ventrally. No pronounced constriction at neck. A narrow mid-dorsal groove; a broad but shallow mid-ventral groove. Costal grooves 15, extending dorsally to the mid-dorsal groove and connecting across the

venter. Costal folds between adpressed toes, two. Vent a short, slightly elevated slit; internal lips folded.

Tail shorter than head and body; 1.22 times in head and body length; not constricted at base; ovate in cross section at base becoming gradually compressed to flattened tip. No tail fins present; posterior fourth of tail slightly keeled above.

Fore limbs moderately stout; fingers four, moderately slender, unwebbed; 3-2-4-1 in order of decreasing length; no metacarpal tubercles present. Hind limbs moderately stout; toes five, moderately slender, unwebbed, 4-3-2-5-1 on right foot; second toe on left foot amputated; no metatarsal tubercles present.

Tongue moderate, slightly free on sides, with a longitudinal median depression from which the plicæ originate. Premaxillary-maxillary teeth rounded, knob-like, arranged in several ill-defined rows, a maximum of four rows in the middle of the upper jaw, tapering to two rows posteriorly. Mandibular teeth similar in structure but more uniformly arranged in rows, essentially three rows present at mandibular symphysis, but at one or two points a fourth row can be discerned; tapering to one or two rows posteriorly. Vomerine teeth rounded, knob-like, arranged in two elongate patches between posterior margins of internal nares; distance between patches about one-half the width of an internal naris; neither patch extending laterally to behind the naris; fourteen teeth in left patch, eleven teeth in right patch. Internal nares moderate, rounded.

Coloration (preserved): Ground color above, blackish; dorsal pattern consisting essentially of reticulations which are formed in the following manner: on each side, from the angle of the jaws to the base of the tail, there is a creamish-yellow, lichen-like area interspersed with gray vermiculations. Between the axilla and groin there arises from this creamish-yellow area a series of narrow, gray bands which pass upward, generally one present on each costal fold. As these bands pass upward they frequently anastomose to form reticulations. About one-third of them continue up and meet their fellows from the opposite side on the mid-line of the back. The pattern on the top of the head and the dorsal surface of the tail is essentially the same except that the narrow, gray bands do not follow costal folds. Ventrally, the pattern of the throat, belly, and under surfaces of the tail, and limbs, is composed of innumerable tiny white areas on a ground color of grayish-black, giving a salt and pepper appearance. The dorsal surfaces of the limbs have narrow, gray bands similar to those on the back.

Coloration in life: In life the ground color of the dorsum was a chocolate-black and the narrow dorsal bands were a brownish-gray. The lateral, lichen-like areas on the sides of the head and between the axilla and groin were pearl-gray; hence these lichen-like areas and the dorsal bands arising from them were appreciably different in coloration. The ventral ground color was black and the ventral light markings were a diffuse gray.

Measurements (in millimeters): Head width, 8; head length, 13; body length, 43.5; tail length, 46.5; axilla to groin, 30; fore limb, 12; hind limb, 13; total length, 103.

Variation: Fresh adult material of *A. c. bishopi* is rather uniform in coloration, but there is some variation in the dorsal pattern. The ground color of the dorsum is a chocolate-black and the lateral, lichen-like marks between the axilla and groin are gray, but the narrow bands which arise from this lateral, gray area, generally one on each costal fold, are a definite brownish-gray. Thus in life the dorsal bands seem to arise from, but not be continuations of, the lateral, gray areas whereas in *A. c. cingulatum* the dorsal bands seem to be mere continuations of the lateral, gray areas. In the majority of the adult specimens of fresh material the dorsal, light marks tend to divide and anastomose, giving a definitely reticulated appearance to the dorsal surface. Markings similar to those of the back are present on the top of the head and sides and top of the tail. In a specimen which I still have alive in a terrarium (plate 1, fig. 5) the brownish-gray bands arising from the lateral, gray areas and ascending on the costal folds show the minimum amount of branching or anastomosing, the great majority of them continuing uninterruptedly to the mid-line of the back where they meet their fellows from the opposite side, giving the individual an annulate rather than a reticulate appearance.

Ventrally, the ground color is black with numerous tiny, anastomosing, gray flecks giving the throat, venter, and under side of the tail, a salt and pepper appearance. In general, the dark pigment ventrally is more concentrated posteriorly so that there is an indefinite gradient in tone with the animal being lightest under the chin and throat, intermediate on the venter, and darkest on the ventral side of the tail.

As so much of the heretofore available material was old and in such poor condition that teeth and costal grooves could not be counted or accurate measurements made, I list in Table 1 tooth counts, costal groove counts, and measurements of eleven recently collected and well preserved specimens of *A. c. bishopi* that are 50 mm. or more in head and body length. From this table it can be seen that the costal grooves (all forks

counted) are constant at 15. The axilla to groin length seems to be on the average greater in relation to the head length and the limb length than it is in *A. c. cingulatum*. In this fresh, adult material of *bishopi* the number of costal folds between adpressed toes ranges from 2 to 4 with an average of 3.23. In axilla to groin length divided by head length, *bishopi* ranges from 2.23 to 2.77 with an average of 2.52.

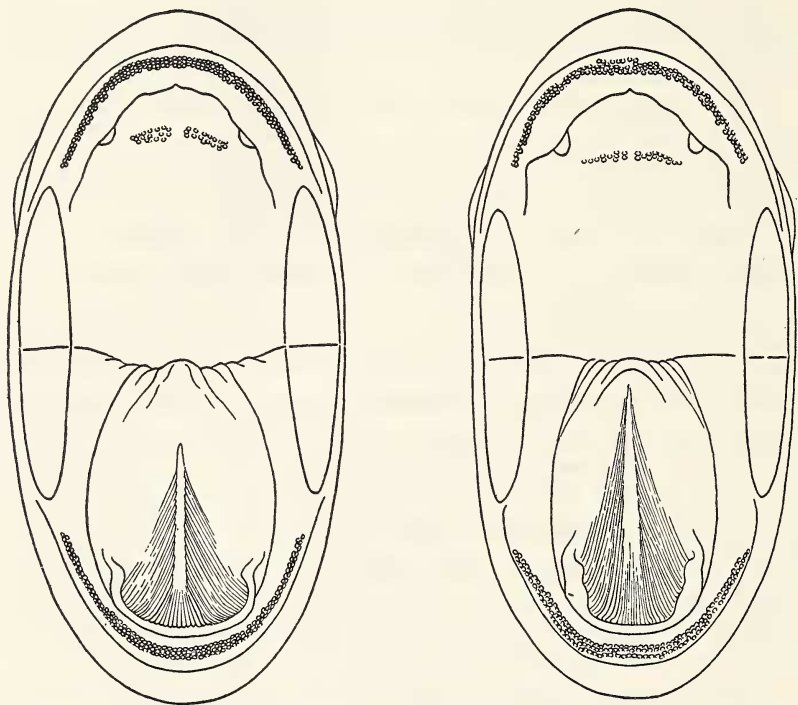


FIG. 1. Left, teeth of *Ambystoma c. cingulatum* from Emanuel Co., Georgia, CM 29,145. Right, teeth of *Ambystoma c. bishopi* from Escambia Co., Florida, CM 29,137 (type).

If all specimens in which I have been able to make accurate counts are considered, the number of rows of teeth on the premaxillary-maxillary occur in the following order of frequency: 3, seven times; 4, thirty-five times; 5, eight times; and 6, once. The numbers of rows of teeth on the mandibles occur as follows: 3, twenty-two times; 4, twenty-six times; and 5, twice. In all specimens in which accurate counts of vomerine teeth were possible, the number in each patch ranges from 5 to 20 with an average of 13.2. In general, the vomerine teeth in *A. c. bishopi* are arranged in

Museum	Number	Costal Grooves	Vomerine Teeth	Costal Folds between adpressed toes	Head and Body Length	Head Length	Head Width	Tail Length	Axilla to Groin	Total Length
JWC	293	15-15	13-17	4	62	13	7.8	32	36	94
SCB	1547	15-15	10-10	4	61	13	8.5	51	33	112
Tulane	11824	15-15	7-5	4	61	12.5	8.7	43	33	104 ²
ANSP	26274	15-15	18-19	3	59	13	9.6	49	33	108
ANSP	26275	15-15	7-8	3+	59	12	8.7	39	30	98
CM	29138	15-15	11-18	4	57	12	8.6	46	31	103 ²
CAS	15551	15-15	5-6	3½	55	11.5	8.4	37	31	92
CM	29137	15-15	14-11	2	55	13	8.0	46.5	30	103
CM	29139	15-15	5-9	3	55	12	8.0	57	31	112
UMMZ	100695	15-15	13-14	2	55	13	7.7	34	29	89
DBUF	344	15-15	--	3	52	12	7.8	36	28	88 ²

TABLE 1. Costal groove counts, vomerine tooth counts, and measurements of eleven fresh specimens of *A. c. bishopi* 50 mm. or more in head and body length.

² Tip of tail broken.

two rows whereas in *A. c. cingulatum* they show a definite tendency to be arranged in three rows.

In general build, an adult specimen of *bishopi* usually lacks a definite constriction at the neck and has a broad, heavy tail. This is in contradistinction to *A. c. cingulatum*, a form which has a rather definite neck and generally a more slender tail.

Specimens from Calhoun County, Florida, approach *c. cingulatum* in three respects: ventral pattern, vomerine tooth number, and costal grooves. The thirty-two specimens in this series were unfortunately placed in a bottle containing preservative too strong, so that they are coiled and quite stiff, hence impossible to measure accurately. Therefore they are not included in the table. In ventral pattern, the ventral, light spots are slightly larger and more scattered than in topotypical *bishopi* although there is some variation within the series. In the vomerine tooth-count, the series ranges from 12-12 in the specimen having the lowest count to 21-21 in the specimen with the highest, and averages 14.5 in each patch, which is above Pensacola specimens which average 9.7 in each patch, but below *cingulatum* which averages 15.6 in each patch. Two of the thirty-two specimens have 16 costal grooves, a count commonly found in *cingulatum*. The specimens JWC 293 from Baker County, Georgia, and UMMZ 100,695 from Early County, Georgia, are like the Calhoun County specimens in having the ventral spots a little larger than they are in the Pensacola specimens. The vomerine tooth-counts are 13-17 and 13-14 respectively. Finally, it should be mentioned that several of the Calhoun County specimens tend to have the vomerine teeth alined in three rather than two rows and thus approach *c. cingulatum* in this respect.

The dorsal pattern seems to be the same as it is in the Pensacola specimens. Although not measurable, in general body form they are comparable to topotypical specimens of *bishopi* and I have therefore included them in the definition of this race.

This Calhoun County series exhibits a certain degree of abnormality in feet and hands. Three specimens have some modification of the normal digital complement. One of these has the middle toe on the left hind foot bifurcate, and the third toe on right foot amputated. In another specimen, the third digit on the right hand has two supernumerary digits growing out of the side of it, and another specimen has the fifth toe missing and the fourth very short on the right hind foot. Finally, one specimen has the left hand amputated.

Sexual dimorphism: In the series of thirty-two specimens from Scott's

Ferry, Calhoun County, there are fifteen males and seventeen females. Sexual dimorphism is not pronounced in this species. The males have the cloacal region slightly swollen but this character is by no means so obvious in this species as it is in the larger species of *Ambystoma*. The most convenient and accurate method of determining sex is by examination of the Müllerian duct, which is pigmented in the males and unpigmented in the females, as is the case in *Salamandra* (see Francis, *The Anatomy of the Salamander*, 1934: 284). The amount of pigmentation is apparently correlated to some extent with age, since the ducts in the larger males are more heavily pigmented than they are in the smaller individuals.

Ambystoma cingulatum cingulatum Cope

FROSTED SALAMANDER

(PLATE 1)

1867. *Ambystoma cingulatum* Cope, Proc. Acad. Nat. Sci. Phila., Vol. XVIII, p. 205.—Strauch, Mem. Imperiale des Sci., St. Petersburg, Tome XVI, no. 4, 1870, p. 65.—Cope, Bull. U. S. Nat. Mus., no. 1, 1875, p. 26.—Boulenger, Cat. Bat. Grad., 1882, p. 50 (part).—Davis and Rice, Ill. State Lab. of Nat. Hist., Bull. no. 5, 1883, p. 11.—Yarrow, Bull. U. S. Nat. Mus., no. 24, 1883, pp. 21, 192.—Garman, Bull. Essex Inst., Vol. XVI, 1884, p. 38.
1886. *Ambystoma lepturum* Cope, Proc. Amer. Philos. Soc., Vol. XXIII, p. 524.—Cope, Amer. Nat., Vol. XXI, 1887, p. 88.
1889. *Chonōrotus cingulatus* Cope, Bull. U. S. Nat. Mus., no. 34, p. 100.
1889. *Linguaelapsis lepturus* Cope, Bull. U. S. Nat. Mus., no. 34, p. 116.
1907. *Ambystoma cingulatus* Brimley, Jour. Elisha Mitchell Sci. Soc., Vol. XXIII, no. 4, p. 153.
1917. *Ambystoma cingulatum* Stejneger and Barbour, *A Check List of North American Amphibians and Reptiles*, 1st ed., p. 8 (part).—Stejneger and Barbour, *A Check List of North American Amphibians and Reptiles*, 2nd ed., 1923, p. 4 (part).—Brimley, Jour. Elisha Mitchell Sci. Soc., Vol. XLII, nos. 1 & 2, 1926, p. 77.—Wright, Ecology, Vol. VII, no. 1, 1926, p. 82.—Stejneger and Barbour, *A Check List of North American Amphibians and Reptiles*, 3rd ed., 1933, p. 4 (part).—Wright, Proc. Nat. Acad. Sci., Vol. XXI, no. 6, 1935, pp. 340, 341 (part).—Wright, Science, Vol. LXXXI, no. 2106, 1935, p. 463 (part).—Gee, South Carolina Vert. Fauna, 1936, p. 1.—Brimley, Carolina Tips, Vol. II, no. 4, 1939, pp. 14, 15.—Stejneger and Barbour, *A Check List of North American Amphibians and Reptiles*, 4th ed., 1939, p. 7 (part).—Carr, Univ. Fla., Biol. Sci. Ser., Vol. III, no. 1, 1940, pp. 30, 46 (part).—Bishop, *Handbook of Salamanders*, 1943, pp. 113, 123-126 (part).—Stejneger and Barbour, Bull. Mus. Comp. Zoöl., Vol. XCIII, no. 1, 1943, p. 9 (part).—Allen and Neill, A checklist of the amphibians and reptiles of Florida, 1949, p. 1 (part).—Neill, A checklist of the amphibians and reptiles of Georgia, 1949, p. 1.
1932. *Ambystoma angulatum* Wright, *Frogs of the Okefinokee Swamp*, p. 10.

Type locality: Grahamville, Jasper County, South Carolina.

Neotype (here selected): USNM 129,396, adult female collected at Robertsville, Jasper County, South Carolina, Nov. 17, 1947, by Wilfred T. Neill.

Diagnosis: An *Ambystoma* with multiple rows of knob-like teeth on both jaws and on the vomers, and with a dorsal pattern consisting of grayish-green, lichen-like marks which tend to form reticulations. From *Ambystoma cingulatum bishopi* it differs in its more slender, delicate build, in having the ventral pattern composed of discrete light spots on a dark background and the dorsal pattern more lichen-like or "frosted" in appearance, and in a tendency toward having the vomerine teeth arranged in three rows and more numerous (average 15.6 in each patch in *cingulatum*, 13.2 in each patch in *bishopi*).

Variation: The fresh material of *A. cingulatum cingulatum* which I have been able to examine is remarkably uniform in general appearance. The dorsal pattern has a ground color of black with extensive, gray, lichen-like markings concentrated along the side between the axilla and groin. On each costal fold these gray, lichen-like marks extend dorsally, generally forking near the mid-line of the back to meet their fellows from the opposite side. Similar diffuse lichen-like marks are present on the top of the head and top and sides of the tail. The general effect of these gray, somewhat indefinite bands on the black background is to give the salamander a lichenose or frosted appearance and Brimley's use of the common name "frosted salamander" seems to me to be appropriate for this subspecies. Ventrally the ground color is black with scattered pearl-gray light spots.

Since much of the material which has heretofore been available for study is old or poorly preserved, I give in Table 2 a list of counts and measurements made on recently collected specimens 50 mm. or more in head and body length. From this table it can be seen that *cingulatum* has a tendency to have sixteen costal grooves (all forks counted) whereas fifteen is the number in the great majority of *bishopi*. It likewise tends to be relatively shorter in axilla to groin length in relation to head and leg length than does *bishopi*. In this fresh, adult material of *cingulatum* the number of costal folds between adpressed toes ranges from 0 to 3 with an average of 1.69. In axilla to groin length, divided by head length, *cingulatum* ranges from 2.08 to 2.62 with an average of 2.33.

There is a pronounced tendency in *cingulatum* for the teeth to be arranged in rather compact groups. The teeth on both jaws are arranged

Museum	Number	Costal Grooves	Vomerine Teeth	Costal Folds between adpressed toes	Head and Body Length	Head Length	Head Width	Tail Length	Axilla to Groin	Total Length
DBUF	2628	16-16	23-19	3	60	13	9.5	49	34	109
DBUF	2629	15-15	14-16	2	56	13	7.9	30	30	86
CM	29145	15-15	17-16	1½	52.5	12.5	7.5	41.5	28	94
ERA-WTN	14005(a)	15-16	15-14	1	52	11	7.4	39	28	91
ANSP	26277	16-15	24-22	1	52	13	8.2	40	27	92
ANSP	26276	16-16	17-15	2	52	12.5	7.7	45.5	28	97.5
ERA-WTN	14005(b)	16-16	13-15	3	51.5	12	8.1	37.5	28	89
USNM	129396	15-15	19-19	0	50	12	7.8	38	27	88

TABLE 2. Costal groove counts, vomerine tooth counts, and measurements of eight fresh specimens of *A. c. cingulatum* 50 mm. or more in head and body length.

in more or less definite rows and in the specimens in which unquestionable counts can be made the rows on the premaxillary-maxillary vary from 3 to 6, occurring in the following frequencies: 3, twice; 4, eight times; 5, three times; and 6, once. On the mandible the number of rows ranges from 2 to 4, occurring in the following frequencies: 2, once; 3, three times; 4, nine times. In vomerine teeth there is a tendency for three rows to be formed on each patch and in fresh material there is definitely a greater number of teeth in each patch than in *bishopi*. Extreme caution should be used in counting vomerine teeth since, if a needle is used in the process, many peripheral teeth may be displaced without leaving a definite gap, thereby causing future workers to obtain a lower count. Thus, at the present time, I am able to count only 12 in each patch on USNM 49,432 from Jacksonville, Florida, a specimen which has been examined many times by many workers, and on USNM 14,583, the type of *A. lepturum* Cope, there are now 9 teeth in the left vomerine patch and 10 on the right. Since in this specimen, however, the vomerine teeth tend to be arranged in three rows, since a faint trace of a ventral pattern similar to that of *c. cingulatum* is still discernible, and since the general build is much more similar to *cingulatum* than it is to *bishopi*, I do not hesitate to consider it a synonym of *A. c. cingulatum*.

I have seen two specimens which are recorded in the literature as coming from Pensacola, Florida, which seem to me to be referable to *cingulatum* rather than to *bishopi*. These are MCZ 204. In both of these specimens the vomerine teeth are uncountable. The larger specimen has 16 costal grooves on the left and 15 on the right, and the smaller I could not count accurately. The smaller of the two specimens is certainly recently transformed and the adult pattern is not fully developed. In the larger, however, although it is somewhat faded dorsally, the ventral pattern is quite distinct and is similar to that seen in fresh material of *cingulatum* and unlike that of any of the fresh material of *bishopi* I have seen from Pensacola. When I queried Mr. Loveridge regarding the data of these two specimens, he told me that the entry in the catalogue of the Museum of Comparative Zoölogy reads as follows: "*Amblystoma jeffersonianum* Bd. var. 2 ex. Pensacola, Fla. Alcoholic. (Collected) 1853. Col. Deas. Prof. Agassiz. Sent to Prof. Baird Jan. 22nd 1859. (entered in register) Feb. 20, 1862." In view of the length of time that elapsed between collection of the specimens and their entry in the catalogue, the possibility of error cannot be ruled out.

LIFE HISTORY

Habitat: Both races of *A. cingulatum* seem to be essentially inhabitants of slash pine—wire grass flatwoods. Every specimen for which detailed ecological notes are available was taken in or near one of the small, shallow, cypress ponds so characteristic of these flatwoods or in a drainage area from such a pond.

Habits: Specimens of *A. c. cingulatum* can be found under logs around the margins of the above-mentioned ponds throughout the winter months. While they appear to be quite capable burrowers, Wilfred T. Neill informs me that they show a pronounced tendency to occupy crayfish burrows.

The recent specimens of *A. c. bishopi* from Escambia County, Florida, have all been taken near an old, abandoned air field which had been made in the flatwoods about five miles north of Pensacola. Most of the specimens were found around the margin of a cypress pond, that has become more or less a dump heap, near the edge of the air field. Specimens have been taken in April, May, June, September, and November by turning over the rubbish in contact with the moist ground. In one case, specimens were found under clods of earth that had been turned up by people digging fishing worms. The specimen from Baker County, Georgia, was taken under a cypress log eight to ten inches in diameter in the nearly dry basin of a similar cypress pond. A specimen of *Triturus v. louisianensis* was under the same log.

The individuals that I kept alive in a terrarium in my back yard from May 7, 1949, to February, 1950, were active burrowers and built extensive tunnels about equal in diameter to that of their bodies through the four inches or so of dirt in the bottom of the terrarium. Some days they would remain in the tunnels, while on others they would rest under a board kept in the terrarium. They generally tended to remain hidden either in the tunnels or under the board except on rainy nights when they would come out and wander about on the surface. During February and March, 1950, the specimen (CJG, 1,869), still alive in the terrarium, had a burrow which had its entrance at the exposed surface rather than under the board. While occupying this burrow it would remain hidden during the day but would often rest at night with just the tip of its head exposed. They made no attempt to climb the glass walls of the terrarium.

Eggs and Breeding Season: Specimens of both subspecies have been found with mature, pigmented eggs in the ovaries. A specimen of *cingulatum* from Jasper County, South Carolina, taken on November 7, 1947,

had twenty-one pigmented eggs in the left ovary and twelve in the right. Another specimen, from Emanuel County, Georgia, collected November 24, 1949, had forty pigmented eggs in the left ovary and thirty in the right.

Two specimens of *A. c. bishopi* with pigmented eggs seem to indicate a rather extensive breeding season. A specimen taken in Escambia County, Florida, in June, 1949, had sixty-three pigmented eggs on the left side of the body and sixty-four on the right, whereas the specimen taken by John Crenshaw in Baker County, Georgia, on January 13, 1950, when killed on January 25, had forty-seven eggs on the left side and fifty-five on the right.

The series of thirty-two specimens taken at Scott's Ferry, Calhoun County, on February 20, 1950, had presumably bred shortly prior to the time of collection. In none of the females were the ovaries full of pigmented eggs and six had obviously spent ovaries in which just a few pigmented eggs were retained. In these six specimens the following numbers of pigmented eggs were found (in each case the first figure is for the left side of the body, the second for the right): 7-2, 3-0, 0-2, 2-4, 0-1, 1-0.

Larvæ and Immatures: Orton (1942: 170) described and illustrated three larval specimens of *Ambystoma* which, on the basis of comparison with known larvæ, she assigned to *cingulatum*. Upon comparison of these larvæ with recently transformed specimens of both races of *cingulatum*, I feel confident that Dr. Orton's identification of them as belonging to this species is correct. In addition to the three larvæ from Jackson County mentioned above, I have seen three recently transformed specimens which retain the larval pattern: AMNH 36,479 (38 mm., head and body length; 65 mm., total length), from Lanier County, Georgia; CM 29,141 (36 mm., head and body length; 57 mm., total length) from Escambia County, Florida; and MCZ 204 B, purportedly from Escambia County, Florida. I have indicated earlier (p. 310) that the adult specimen numbered MCZ 204 seems to be more like *cingulatum* than *bishopi*. Examination of the recently transformed specimen confirms this opinion.

The specimen of *cingulatum* from Lanier County, Georgia, is brown in ground color with a tan stripe extending from axilla to groin and another tan stripe extending from above the arm posteriorly until it fades out on the distal third of the tail. There is a black stripe from the nostril which extends posteriorly through the eye to the vertical extension of the gular fold on the side of the neck. Above this is a slightly lightened area as though the uppermost lateral stripe in life continued on to the side of the head. A narrow mid-dorsal light line extends from the base of the head to

above the insertion of the fore limbs. There is a very narrow black margin along the sides of the upper lip. The venter is very pale brown. The same general coloration and pattern can be made out in MCZ 204 B except that the upper lateral stripe is more indistinct, the adult pattern is becoming discernible on the tail and the venter is becoming more heavily pigmented, leaving spots of unpigmented areas. The specimen of *bishopi* from Escambia County, Florida, although 2 mm. less in head and body length and 8 mm. less in total length than the specimen of *cingulatum*, has more of the adult pattern. Both of the lateral stripes are still present but the stripe between the axilla and groin is breaking up into patches and the superior lateral stripe is not nearly so sharply defined as it is in the specimen from Lanier County, Georgia. Furthermore, although the specimen from Lanier County has a definite dorsal fin on the tail extending from above the vent to the tip, the tail fin is completely obsolete in the Escambia County specimen of *bishopi*. The adult dorsal pattern is beginning to develop between the upper lateral stripes in the specimen of *bishopi*; there is no hint of it in the specimen of *cingulatum*. There is no trace of a mid-dorsal light line in the former.

If these specimens are at all typical as to the size at which the adult color pattern is developed, it would seem that *bishopi* transforms and attains the adult pattern at a smaller size than does *cingulatum*. While the specimen of *cingulatum*, 38 mm. in head and body length, retains the larval coloration and tail fin, the specimen of *bishopi*, 36 mm. in head and body length, is beginning to lose the larval coloration and attain the adult pattern and has completely lost the tail fin. Two other specimens of *bishopi*, collected at the same time and place as the recently transformed one described above, and measuring 36 and 38 mm. in head and body length and 56 and 62 mm. in total length respectively, show the typical sub-adult pattern and have lost all sign of a tail fin.

The sub-adult pattern of *A. c. bishopi* differs from the adult in that the dorsal reticulations are less sharply defined and the venter is paler in coloration. In immature specimens ranging from 36 to 43.4 mm. in head and body length, there is a definite light area on the ventral surface of the throat just anterior to the gular fold, and the chin, venter, and under surface of the tail are paler than in adult specimens. The lichen-like area between the axilla and the groin seems to be less well developed since in specimens of this size the light areas are not confluent but consist of ill-defined but separate light marks.

Growth Rate and Longevity: No information is available regarding *A. c.*

cingulatum but a specimen of *A. c. bishopi*, measuring 35 mm. in head and body length and 56 mm. in total length, was put in my terrarium on May 7, 1949. It fell into a pan of water in the terrarium and drowned, apparently on the night of June 23, since, when I returned from the meetings of the American Society of Ichthyologists and Herpetologists in Washington on June 24, I found it in the pan of water, dead but still in good, fresh condition. At this time, after a lapse of 47 days, it measured 44 mm. in head and body length, an increase of 9 mm., and 73 mm. in total length, an increase of 17 mm.

Two adult specimens of *A. c. bishopi* which were also placed in the terrarium on May 7 thrived until February 7, a period of 9 months, when my two-year old son released one of them in the leaf mold of my back yard. The other is still (July 18, 1950) alive.

Food: Apparently both subspecies feed on earthworms. Three specimens of *A. c. bishopi* taken in September, and one taken in February, had the undigested remains of earthworms in the digestive tract, and one specimen of *A. c. cingulatum* from Jasper County, South Carolina, taken in October, 1947, had no less than seven pieces of earthworm in its stomach. Since five of these pieces were terminal sections, it is evident that parts of at least three individual worms were in the stomach at one time. Many of the series of specimens of *bishopi* taken in February in Calhoun County regurgitated earthworms when they were placed in what was apparently a quite strong preserving fluid, and earthworms were found in eight of the specimens when their digestive tracts were examined after preservation. I have twice found tiny fragments of unidentifiable plant remains in stomachs of *bishopi*, and the majority of stomachs of both subspecies which I have examined have contained at least a few sand grains. This, of course, would be expected if earthworms are a staple in their diet.

The earthworms removed from the salamanders probably belong to the genus *Diplocardia* according to my colleague, Professor E. Ruffin Jones.

I have made no attempt to supply food to the adult specimens which I have kept alive, but the soil which I put into the terrarium came from my back yard, which supports a flourishing annelid population, and worms have frequently been seen in the terrarium. While I have never been able to observe one of the salamanders in the process of eating, they seemed to thrive and apparently there was no other food available.

RANGE

Ambystoma c. cingulatum ranges from Colleton County, South Carolina, and Jefferson County, Georgia, west and south to Lanier County, Georgia, and Duval County, Florida.

Ambystoma c. bishopi seems to be restricted to a region on the Gulf Coastal Plain from Baker County, Georgia, and Calhoun County, Florida, west to Mobile Bay, Alabama. Dr. E. R. Dunn informs me that he has

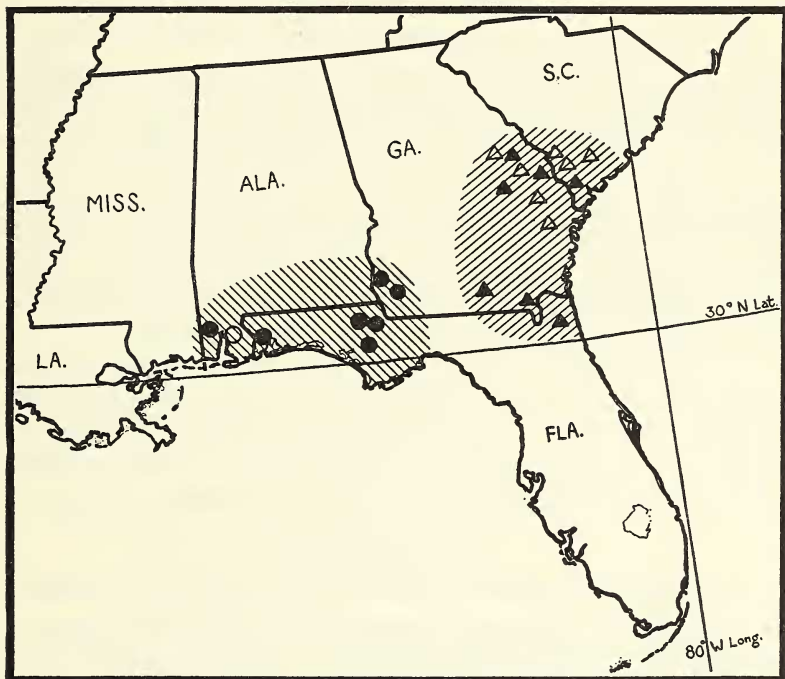


FIG. 2. Map showing the distribution of the subspecies of *Ambystoma cingulatum*. Triangles, *Ambystoma c. cingulatum*; circles, *Ambystoma c. bishopi*. Solid symbols, specimens examined; hollow symbols, literature records.

examined the specimen recorded by Boulenger (1882: 50) from New Orleans, that it is at present uniform black, and that his notes indicate that it is most likely a specimen of *texanum*. Since I have seen a number of fresh specimens of a small dark form of *texanum* from the same vicinity, and since no other specimens of *cingulatum* have ever been taken from there, it seems wisest to me to consider Louisiana beyond the range of *bishopi* unless and until fresh specimens of this subspecies are collected from there.

The accompanying map indicates the distribution of the two subspecies. The solid symbols represent localities from which specimens have been examined by me and the hollow symbols represent literature records. The records represented by hollow symbols from northern Georgia and South Carolina are from Wilfred T. Neill's unpublished manuscript, "The Amphibians of Georgia."

SPECIMENS EXAMINED

Ambystoma cingulatum cingulatum: Nineteen, as follows: South Carolina: Jasper Co., Ridgeland, ERA-WTN 14,007; Robertsville, USNM 129,396 (*neotype*). Georgia: Burke Co., Midville, ANSP 26,277; Charlton Co., 1 mi. E. Chesser School, CU 2,936; 2 mi. E. Chesser Island, CU 2,933; Emanuel Co., ½ mi. S. Midville, Burke Co., ANSP 26,276, CM 29,145, DBUF 2,628-29; McKinney's Pond in northern part of county, ERA-WTN 14,006; Lanier Co., Lakeland, AMNH 36,479, 37,388; Screvin Co., Bascom, ERA-WTN 14,005 (2). Florida: Duval Co., Jacksonville, USNM 49,431-32; ? MCZ 204 (2) (purportedly from Pensacola, Escambia Co.). ?? USNM 14,583, no data (*type of lepturum*).

Ambystoma cingulatum bishopi: In addition to the type and sixty-two paratypes listed, I have seen three additional specimens of *bishopi*. Two of these (MCZ 229) were sent several years ago to the University of Kansas for osteological studies by Mr. Loveridge. The other specimen (CJG 1,870), I kept alive for nine months before it escaped.

ACKNOWLEDGMENTS

I am particularly indebted to Wilfred T. Neill and Harvard E. Nygren for the gift of many specimens. In addition, Mr. Neill has kindly made his unpublished manuscript on "The Amphibians of Georgia" available to me. I wish to thank Dr. E. R. Dunn and Dr. Sherman C. Bishop for their valuable suggestions and assistance. For the loan of material I wish to thank E. Ross Allen of Ross Allen's Reptile Institute, Charles M. Bogert of the American Museum of Natural History, Doris M. Cochran of the United States National Museum, Arthur Loveridge of the Museum of Comparative Zoölogy, M. Graham Netting and Grace Orton of the Carnegie Museum, Charles F. Walker of the Museum of Zoology, University of Michigan, A. H. Wright and Edward C. Raney of Cornell University, Fred R. Cagle of Tulane University, and John W. Crenshaw of Emory University Field Station, Newton, Georgia. The drawings are from the pen of Miss Esther Coogle. To her I owe my thanks.

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ADDENDA

After the above paper was submitted for publication, four students at the University of Florida collected a series of *A. c. bishopi* which provides data on abundance. On April 7, 1950, Messrs. David Beecher, Byrum W. Cooper, Robert Hellman, and Edwin H. McConkey collected forty-five specimens about three miles south of Mariana, Jackson County, Florida. These specimens were taken in low slash pine—wire grass flatwoods in an area approximately $\frac{1}{8}$ by $\frac{1}{4}$ of a mile in extent. The region had been recently cut over for timber, and logs about six feet in length had been left lying by the stumps. The four students collected the entire series between four and six in the evening by looking under these logs. Some of them had two or three *bishopi* under them and one had five.

Manculus q. quadridigitatus, *Microhyla c. carolinensis*, and *Storeria d. wrightorum* were found under the same logs as the *Ambystoma*. Eight specimens of *Pseudotriton m. floridanus* were found under logs in damper places in the same general locality but were not taken under the same logs with *bishopi*.

EXPLANATION OF PLATE 1

MISS ESTHER COOGLE, del.

- FIG. 1. Dorsolateral view of *Ambystoma c. cingulatum* from Emanuel Co., Georgia, in life. (CM 29,145)
- FIG. 2. Ventral view of same.
- FIG. 3. Dorsolateral view of *Ambystoma c. bishopi* from Escambia Co., Florida, in life. (CM 29,137, type)
- FIG. 4. Ventral view of same.
- FIG. 5. Dorsolateral view of *Ambystoma c. bishopi* from Escambia Co., Florida showing maximum degree of annulation. (CJG 1,869).